

Cicadina 13 (2013): 5-15

***Penestrangia apicalis* (Osborn & Ball, 1898),
another invasive Nearctic leafhopper found in Europe
(Hemiptera: Cicadellidae, Iassinae)**

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Summary: In 2010 the Nearctic leafhopper *Penestrangia apicalis* (Osborn & Ball) was found for the first time in Europe. Altogether there are now 16 known localities in France, Switzerland, Germany and Austria indicating that the species is well established for a rather long period and more widespread in Europe and perhaps worldwide. As in North America it lives on honeylocust (*Gleditsia triacanthos* L.), overwinters in the egg stage and probably has one or two generations a year, with adults at least from late June until early October. It is yet unclear if it causes relevant damage to the host plant in Europe.

Keywords: alien species, neozoa, plant pests, Iassinae, *Gleditsia*

1. Introduction

In 2012 a leafhopper was found in several localities in central Europe that was hitherto unknown to European hemipterists. Extensive search in taxonomic literature from all around the world revealed that it was *Penestrangia apicalis* (Osborn & Ball, 1898). This species was originally described from Iowa and Nebraska as a member of the genus *Macropsis* Lewis, 1834 (see Osborn & Ball 1898a), later placed into *Bythoscopus* Germar, 1833, *Strangania* Stål, 1862 (see Metcalf 1966a), and finally *Penestrangia* Beamer & Lawson, 1945. The latter was originally erected as a subgenus only and later raised to genus level by Blocker (1979) who limited the genus *Strangania* to the type species *St. ornatula* (Stål). Therefore the hitherto used synonymies are as follows:

Macropsis apicalis Osborn & Ball, 1898a

Bythoscopus apicalis Van Duzee, 1916

Strangania apicalis Medler, 1943

Strangania (*Penestrangia*) *apicalis* Beamer & Lawson, 1945

Penestrangia apicalis Blocker, 1979

Blocker (1970) recorded specimens from Iowa, Indiana, Colorado, Kansas, Louisiana, Missouri and Utah. After Metcalf (1966a) the species has also been reported from Nebraska, Alabama, Ohio, Tennessee, Virginia, New York, Illinois, Minne-

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sota, Georgia and Quebec. Furthermore, it was found in Pennsylvania, Vermont (Valley & Wheeler 1985) and southern Ontario (Hamilton 1985). It is included in several leafhopper monographs of the United States such as Kansas (Lawson 1920), Illinois (DeLong 1948), Ohio (Osborn (1928) and Canada (Beirne 1956, Hamilton 1985).

Blocker (1970) also mentions China and Japan, but this refers to an erroneous citation by Metcalf (1966a) of Schumacher (1915) who listed *Pediopsis apicalis* Matsu-mura, 1912 from Taiwan. This species, however, does not belong to the Iassinae, but to the Macropsinae, has an Oriental distribution and lives on *Quercus*. It was later renamed as *Macropsis kyushuensis* Metcalf, 1966 (see Metcalf 1966b).

2. Records from Europe

Penestragania apicalis (Osb. & Ball.) was first identified after a specimen collected in Heilbronn (SW Germany) in September 2012 and then recognized as being conspecific with an unidentified specimen found in Basel, Switzerland, two months earlier. After proper identification and gathering of ecological information we made a targeted search on hostplants in several cities which produced further records in Hannover, Karlsruhe, Heidelberg, Freiburg, Cottbus, Berlin, Erfurt (all Germany), Salzburg, Graz, Vienna, Laxenburg (all Austria). More stands of honeylocust were swept in Italy (regions of Lombardia and Veneto), the Netherlands (Groningen, Utrecht) and Germany (Kiel, Göttingen) but without any positive records. Shortly before submitting the manuscript accidental correspondence yielded the French records from Strasbourg (Alsace), which proved to be two years older than all others. The following section summarises the European records in chronological order (all specimens collected on *Gleditsia triacanthos* L. if not otherwise stated); see also Fig. 11.

1. France, Bas-Rhin, Strasbourg, Botanical Garden, 48° 35' 05" N, 7° 45' 59" E, 137 m, 30 June 2010, 2 ♂♂, 1 ♀, 21 June 2011, 6 ♂♂, 26 June 2012, 1 ♂, all attracted by a UV lamp on a balcony, close to the garden; 19 July 2011, 1 ♀, within the garden, N 48° 34' 58", E 7° 46' 03", three species of *Gleditsia* including *G. triacanthos* L. being present (all leg. H. Callot).
2. Switzerland, city of Basel, N 47° 33' 3", E 7° 35' 22", 273 m, 11 July 2012, 1 ♂, on *Betula pendula* (leg. T. Turrini-Biedermann).
3. Germany, Baden-Württemberg: Heilbronn, Steinstraße, N 49° 8' 12", E 9° 13' 26", 175 m, 14 Sept 2012, 2 ♀♀ (leg. K. Schrameyer).
4. Germany, Baden-Württemberg: Heilbronn, Böllinger Höfe, N 49° 10' 54", E 9° 9' 42", 195 m, 1 ♀, 20 Sept 2012 (leg. K. Schrameyer).
5. Germany, Niedersachsen: Hannover, Georgengarten, N 52° 22' 60", E 9° 42' 47", 54 m, 20 Sept 2012, 1 ♀ (leg. P. Sprick).
6. Germany, Baden-Württemberg: Karlsruhe, August-Dosenbach-Straße, N 49° 00' 7", E 8° 20' 34", 115 m, 4 Oct 2012, 4 ♀♀, and again 1 July 2013, numerous adults and nymphs (leg. H. Nickel).

7. Germany, Brandenburg, Cottbus, Friedrich-Ebert-Straße – Hubert-Straße, N 51° 45' 54", E 14° 19' 54", 80 m, 25 Jul 2013, 3 ♀♀ (leg. M. Lehmann).
8. Germany, Baden-Württemberg, Heidelberg, Willy-Brandt-Platz, N 49° 24' 14", E 8° 40' 39", 114 m, 31 July (leg. J. Gunczy & G. Kunz).
9. Germany, Baden-Württemberg, Freiburg im Breisgau, N 48° 0' 29", E 7° 50' 46", 260 m, 3 Aug 2013, 1 ♂, 3 ♀♀ (leg. G. Kunz).
10. Austria, Salzburg, Stadt Salzburg, Hellbrunner Park, N 47° 45' 42"; E 13° 03' 48", 431 m, 18 Aug 2013, 4 ♂♂, 5 ♀♀ (leg. T. Wurzinger & G. Kunz).
11. Austria, Steiermark, Graz, Stadtpark, N 47° 04' 30"; E 15° 26' 44", 373 m, 19 Aug 2013, 1 ♂ (leg. J. Gunczy & G. Kunz).
12. Austria, Wien, Aspern, N 48° 13' 06"; E 16° 28' 60", 158 m, 22 Aug 2013, 3 ♂♂, 3 ♀♀, 1 nymph (leg. J. Gunczy & G. Kunz).
13. Austria, Niederösterreich, Laxenburg, Schlossgarten, N 48° 3' 42"; E 16° 21' 43", 175 m, 24 Aug 2013, 2 ♂♂, 3 ♀♀, 1 nymph (leg. J. Gunczy & G. Kunz).
14. Germany, Berlin, Hellersdorf, Neue Grottkauer Straße, 52° 31' 44" N, 13° 35' 36" E, 54 m, 30 Aug 2013, a large population, including nymphs (leg. H. Nickel)
15. Germany, Sachsen, Dresden, Großer Garten, 51° 02' 20" N, 13° 45' 37" E, 120 m, 2 Sept 2013, 4 ♀♀ (leg. S. Walter).
16. Germany, Thüringen; Erfurt, Leipziger Straße 77, 50° 59' 28" N, 11° 3' 15" E, 10 Oct 2013, 190 m, 1 ♀ (leg. H. Nickel).

3. Identification

Compared to other species of European leafhoppers and members of the subfamily Iassinae, *P. apicalis* (Osb. & Ball.) can be easily distinguished by the combination of three semicircular dark apical forewing spots, the hair cover and the whitish venation on the fore wings, the parallel fore and hind margins of the head, the transverse wrinkling of the pronotum and the shape of the genitalia (see Figs. 1-8). The most similar species is *P. alabamensis* (Baker) which has hook-like styles and arcuate pygophor appendages with a long and evenly tapering apex, whereas in *P. apicalis* (Osb. & Ball.) the pygophor appendages are angularly bent with a short apex (Fig. 7a) and styles are apically only slightly curved (Fig. 7 b) – see Blocker (1970). Length of North American specimens: ♂♂ 4,3 – 4,9 mm, ♀♀ 4,4 – 5,2 mm.

Nymphs are densely covered with hairs, the longer ones being spatulate, very much like in *Batracomorphus* spp. (Valley & Wheeler 1985). However, the head is as wide as the pronotum, whereas it is narrower in *Batracomorphus* (Fig. 9, see also Stöckmann et al. 2013).

4. Life history

Valley & Wheeler (1985) gave the most comprehensive account on the life history which is extracted in the following section. They summarised earlier literature (Osborn & Ball 1898b, DeLong 1948), and added data based on their own extensive field work conducted between 1975 and 1983 in Pennsylvania. Accordingly, this



Figs. 1-7: *Penestragania apicalis* (Osb. & Ball): 1, 3, 5: adult ♂, Freiburg im Breisgau ; 2, 4, 6: adult ♀, Heidelberg. 7: ♂ genitalia, Basel: left and right pygofer appendages (a), styles and genital plates (b), aedeagus (c).



Fig. 8: *Penestrangia apicalis* (Osborne & Ball) on its hostplant, Heilbronn (Photo: K. Schrameyer). Note the dark spots on wing tips, whitish veins and the hair cover on wings.

leafhopper is monophagous on honeylocust, *Gleditsia triacanthos* L. (Fabaceae), a tree that is native to the east-central United States, but that is widely planted as an ornamental. The species overwinters in the egg stage in twigs of the current season. Nymphs were found between early May and early July, adults between late June and October with a maximum in June and July. The bulk of field data suggest a single generation per year, although there are some late records of ♂♂ which may indicate a second generation.

Feeding takes place on all parts of the leaf (rhachis, blade, main stalk, leaflet stalks, flower stalks). Valley & Wheeler (1985) also reported a hitherto unidentified dryinid wasp of the subfamily Anteoninae that attacked altogether 10 % and 13 % of the leafhopper nymphs in two study years, respectively.

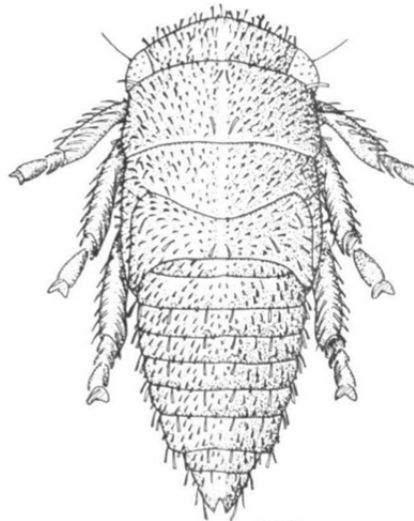


Fig. 9: *Penestrangia apicalis* (Osborne & Ball), fifth instar nymph (drawing courtesy of K. Valley, A.G. Wheeler and Entomological Society of America). Note the dense body cover of spatulate hairs.

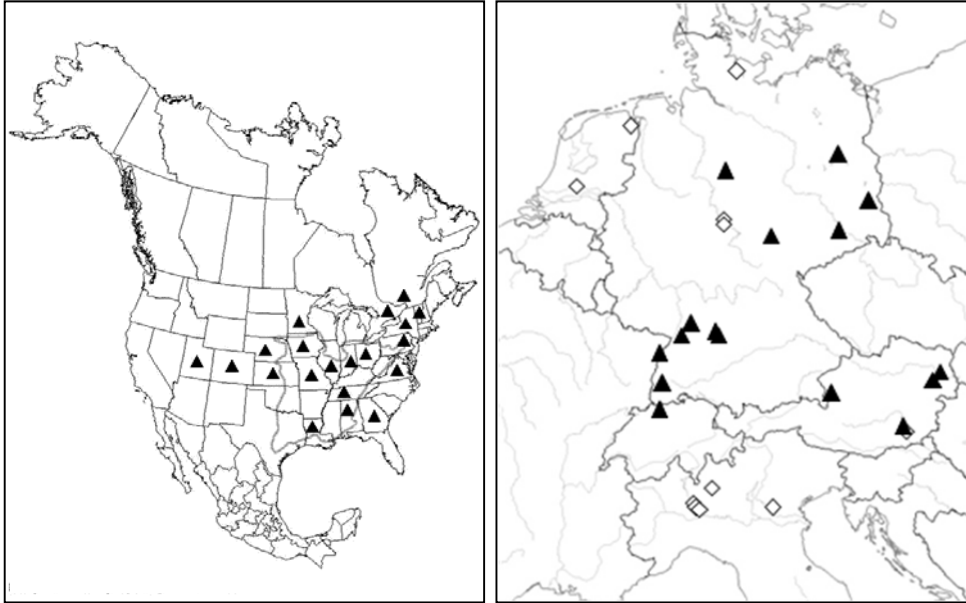


Fig. 10: Native range of *Penestragania apicalis* (Osb. & Ball). Black triangles indicate states (see text) with positive records. The grayish line shows the native range of the hostplant *Gleditsia triacanthos* L. (redrawn after Blair 1990).

Fig. 11: European records of *Penestragania apicalis* (Osb. & Ball). Black triangles show positive records, empty diamonds show negative records on host plants. All data gathered between 2010 and 2013.

In Europe so far most records are from *Gleditsia triacanthos* L. (though in the French locality there are also single individuals of *G. sinensis* Lam. and *G. japonica* Miq.) which however did not yield any specimens. The Swiss record is from *Betula pendula* Roth and probably refers to a stray specimen. Adults were found between late June and early October, nymphs in early July and late August, which largely corresponds with the period in North America (see above). Future fieldwork should prove if the species has expanded its host range towards Asian honeylocusts, and if it is attacked by dryinid wasps or other parasitoids.

5. Other insect species found on *Gleditsia triacanthos* L.

In North America major pests on honeylocust include the galactiid moth *Homadaula anisocentra* Meyrick (“mimosa webworm”), the mirid bug *Diaphnocoris chlorionis* (Say) (“honeylocust plant bug”), and the tetranychid mite *Platytetranychus multidigituli* (Ewing) (“honeylocust spider mite”) (e.g. Sadof 1997, Sperry et al. 2001). Apparently none of these has so far been recorded from Europe. Among leafhoppers Valley & Wheeler (1985) and Hamilton (1985) found *Penestragania alabamensis* (Bak.), *Macropsis fumipennis* (Gill. & Bak.), *Orientus ishidae* (Mats.), *Empo-*

asca fabae (Harris) and three species of *Erythroneura*, the latter in small numbers only. Only the first two species are mentioned as monophages of honeylocust.

In contrast *O. ishidae* (Mats.) is a rather polyphagous eastern Asian species that has been introduced into the Nearctic a century ago (Hamilton 1983). In Europe it was first found in 1998 (Guglielmino 2005) and has spread over large parts of Germany within only 10 years (Nickel 2010). This species was also swept from honeylocust in Göttingen, central Germany (a single ♂ on 20 September 2012).

In recent years the two east Asian honeylocust-feeding bruchid beetles, *Megabruchidius tonkineus* (Pic, 1904) and *M. dorsalis* (Fährhaeus, 1839), have invaded Europe where they feed on the Nearctic *Gleditsia triacanthos* L. The first species has been found as early as 1980 in Germany (Wendt 1980), later in large numbers in Hungary (Jermy et al. 2002, György 2007), France (Delobel 2008), and southern Russia (Korotyaev 2011). The second one was first observed in Italy in 1989 (Migliaccio & Zampetti 1989), then in France (Fritsche et al. 2012). On 13 Oct 2012 one specimen of *M. dorsalis* was found close to a stand of *Gleditsia* (a single tree of *G. triacanthos*, *G. sinensis* and *G. japonica*, respectively) in the Botanical Garden in Strasbourg (H. Callot, unpublished). The gall midge *Dasineura gleditchiae* (Osten Sacken, 1866) (Diptera, Cecidomyiidae) is another Nearctic invasive on honeylocust. It was first recorded for Europe in the Netherlands in 1975. Since then it has colonized at least 15 further countries mainly in southern and central Europe and has caused frequent plant damages (Anonymous 2008).

It would be rather interesting to make further observations on how introduced eastern Asian feeders of *Gleditsia japonensis* Miq. and *G. sinensis* Lam. cope with the Nearctic *G. triacanthos* L., and vice versa, how Nearctic phytophages cope with Asian *Gleditsia* spp.

6. Economic importance

Valley & Wheeler (1985) encountered dead terminal twigs on infested trees, but they attribute this to the presence of other insect pests, mainly the mirid bug *Diaphnocoris chlorionis* (Say) and the mimosa webworm *Homadaula anisocentra* Meyrick rather than to the leafhopper. On host stands in Europe no significant damage has been observed so far.

7. Discussion

As in other insects the trend of introductions of exotic Auchenorrhyncha into Europe is continuing and perhaps even accelerating. Mifsud et al. (2010) have recently summarised the cases known so far. Since then there have been further additions, e.g. the east Asian leafhoppers *Arboridia kakogawana* (Matsumura, 1932) (Gnezdilov et al. 2008), *Hishimonoides sellatiformis* Ishihara, 1965 (Gnezdilov 2008), *Sophonia orientalis* (Matsumura, 1912) (Wilson 2011), *Macropsis illota* (Horvath, 1899) (Li et al.

2012) and *Hishimonus hamatus* Kuoh, 1976 (Seljak, in press) that increase the share of Asian species compared to North American ones to almost a half. Another record, incidentally published as the east Asian leafhopper *Scaphoideus rubroguttatus* Matsumura, 1914 (Nusillard 2007) was described as a new species *S. dellagiustinai* Webb & Viraktamath, 2007 with proven records only from western Africa and southern France. Therefore the evidence of an introduction is not convincing for this species.

A question that arises is how long *Penestragania apicalis* (Osborn & Ball) has been living in Europe without being discovered by entomologists. In fact it is well possible that an insect restricted to an uncommon and spiny tree that is difficult to sweep might go unnoticed for many years. *Gleditsia triacanthos* L. was neither mentioned by any investigators of urban green (Chudzicka 1986, Olthoff 1986, Frommer 1996) nor of European trees in general (Nickel et al. 2002, Löcker 2003, Nickel 2003, 2008). Because of the long distances between the European localities, the relatively old age of some host trees and the high frequency of occurrence on the sampled host plants it is possible that the introduction may date back several decades. An enquiry of local managers of urban green concerning the age of occupied trees could help to narrow down the time of appearance of the leafhopper.

Since *Gleditsia triacanthos* L. is nowadays found worldwide in large parts of the temperate zone (CABI 2013), it seems likely that its associated phytophages are also more widespread. Therefore it should be checked if honeylocust trees in South America, Africa, SW Asia, Australia and New Zealand are infested by *Penestragania apicalis* (Osborn & Ball) and other insects.

Another question is how a monophagous insect like this can disperse on a relatively rare host plant. Unlike more polyphagous invaders such as *Stictocephala bisonia* Kopp & Yonke or *Orientus ishidae* (Mats.), *Penestragania apicalis* (Osborn & Ball) is entirely confined to a hostplant that is rather uncommon, often planted singly and restricted to urban areas. Therefore it seems likely that dispersal of this species would happen mostly through tree nurseries and trade.

8. Zusammenfassung

***Penestragania apicalis* (Osborn & Ball, 1898), eine weitere invasive nearktische Zikade in Europa gefunden (Hemiptera: Cicadellidae, Iassinae).** – Im Jahr 2010 wurde die nearktische Zikadenart *Penestragania apicalis* (Osborn & Ball) erstmalig in Europa gefunden. Insgesamt sind derzeit 16 Fundorte in Frankreich, der Schweiz, Deutschland und Österreich bekannt; daher ist davon auszugehen, dass die Art bereits seit längerer Zeit fest etabliert und in Europa und vielleicht weltweit weiter verbreitet ist. Wie in Nordamerika lebt sie an Gleditschie (*Gleditsia triacanthos* L.), überwintert im Eistadium und hat eine oder zwei Generation pro Jahr, mit adulten

Tieren von mindestens Ende Juni bis Anfang Oktober. Ob in Europa wirtschaftlich relevante Schäden verursacht werden, ist noch unklar.

Acknowledgements

Thanks to A.G. Wheeler (Clemson, South Carolina) and Alan Kahan (Entomological Society of America) for the permission to include the drawing of the nymph and for reading the manuscript. Thanks also to Manfred Lehmann (Cottbus) for sending specimens from Brandenburg, to Roel van Klink (Kiel, Germany), Danilo Piccolino (Vigevano, Italy), Francesco Poggi (Missaglia, Italy) and Francesco Sanna (Bovolone, Italy) for communicating negative host records from Italy, the Netherlands and Germany.

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